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Evaluation in the Modifications in Canal Anatomy of Curved Canals Following Glide Path Preparation using Path Files, G-Files and Hyflex Glide Path Files

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Abstract

Introduction

The instrumentation and preparation of the root canal system is regarded as being a most important stage of endodontic treatment for this has an influence on the efficacy of subsequent procedures in endodontic therapy. Root canal instrumentation was originally aimed at facilitating the placement of medicaments in the root canal and little attempt was made to clear the organic contents from the root canal system. The focus of instrumentation then shifted to preparing the root canal space to facilitate the placement of root canal fillings but the methods employed were mostly unrelated to the anatomy of the canal system or to the properties of the obturation materials. In 1974, Schilder altered endodontic protocols forever with his innovative and revolutionary concepts that defined the design and biological objectives for optimally shaping canal spaces and for debriding root canal systems. There were several primary objectives – shaping the root canal system to have a smooth taper from orifice to apex; keeping the apical foramen as small as was practical and in its original position; and ensuring that the preparation flowed with the original anatomy of the root canal system. Other objectives were to confine preparation to the canal space, facilitate the removal of all tissue without forcing necrotic debris through the apical foramen, and ensuring that the final shape facilitated the placement of medicaments and exchange of irrigants.

However, the journey from orifice to apex can be perilous and proper root canal preparation remains one of the most difficult tasks in endodontic therapy. Canal scouting and preflaring are the first phases of canal instrumentation and

it has also been noted that during these phases the clinician might more frequently encounter procedural difficulties. Instrumentation of canals with multi-planar curvatures and long, thin curved canals is fraught with possible procedural errors during either hand-file instrumentation or rotary nickel titanium (Ni-Ti) instrumentation. During preparation, especially when preparing curved canals, iatrogenic errors, such as ledges, zips, perforations, and root canal transportation, can occur. Technological advancements in rotary nickel-titanium (Ni-Ti) instruments have led to new design concepts and easier and faster techniques that preserve the original canal shape with considerably less iatrogenic error. Most of the procedural problems associated with achieving ideal shaping of curved canals were due to the stiffness of stainless steel instruments. Nickel-titanium (Ni-Ti) rotary instruments were introduced to improve root canal preparation. Ni-Ti rotary instruments revolutionised endodontics as they have a lower modulus of elasticity than stainless steel instruments; and therefore exert fewer lateral forces on the dentine walls in curved canals. Even though Ni-Ti instruments are stronger and more flexible than their stainless steel counterparts fractures may still occur within their elastic limit. Fracture of rotary Ni-Ti instruments may occur as a result of cyclic flexural fatigue (bending stress) or through torsion (shear stress).

John West in 2006 defined the glide path as a smooth, though possibly narrow, tunnel or passage from the coronal orifice of the canal to the radiographic terminus or electronically determined portal of exit. The endodontic glidepath is a smooth radicular tunnel from canal orifice to physiologic terminus (foraminal constriction) of the root canal. The glidepath must be discovered if already present in the endodontic anatomy or prepared if it is not present. The glidepath can be short or long, narrow or wide, essentially straight or curved. Its minimal size should be a “super loose No. 10” endodontic file.

What the rationale of endodontics requires is the entire length of the root canal system be cleaned and shaped. Glide Path is pre requisite to this mechanical objective. A glide path is achieved when the file forming it can enter from the orifice and follow the smooth canal walls uninterrupted to the terminus.The lack of glide path establishment may result in ledge formation, blockage of root canals, transportation, zip formation and perforation.Glide path helps prevent torque failure and cyclic fatigue.Glidepath is the secret to radicular rotary safety and marks the path of modern endodontics. By creating a glide path we can maintain the original canal anatomy with less modification of canal curvature and fewer canal aberrations. Cone Beam Computed Tomography (CBCT) provides a significantly faster image acquisition and reconstruction scheme and aids in the diagnosis of canal morphology. As compared with conventional periapical radiography, CBCT eliminate superimposition of surrounding structures, providing additional clinically relevant information. Even though resolution is not as high as that of conventional radiographs, the availability of 3-Dimensional information, a relatively higher resolution and a significantly lower dose than medical-grade Computed Tomography makes CBCT the imaging modality of choice in challenging situations demanding localization and characterization of root canals

The aim of this study is to compare the changes in the root canal anatomy after creation of glide three different NiTi rotary instruments.

Keywords:NiTi, CBCT, Root Canal

Materials and Method

Thirty six periodontally involved and caries free mandibular first molars were collected from a pool of

extracted teeth stored in 10% formalin. Only the teeth with intact and mature root apices were included in the study. Inclusion criteria stipulated that the tooth had a curved mesial root with two separate canals and apices, with curvature angles ranging within 20-40° (Schneider 1971). Standardized radiographs were taken in a buccolingual and mesiodistal dimension before the instrumentation. The specimens were placed in a radiographic mount made of a silicone-based impression material (Aquasil Ultra; Dentsply International, New York, NY) so that a constant position could be obtained. This mount was positioned on a radiographic-paralleling device. The radiographs in the buccal-lingual dimension were taken to confirm the presence of two distinct and separate root canals. In the mesiodistal dimension, K file no. 10 was inserted into the buccal and lingual canal to assess the degree of root canal curvatures according to Schneider's technique. Coronal access was achieved by using Endo-Access and Endo-Z burs (Dentsply Maillefer, Ballaigues, Switzerland) to obtain a straight line access. Each tooth was sectioned through the furcation and the mesial portion of the root and crown was used. Distal roots with the respective part of the crown were sectioned at the furcation level and discarded. All mesial root canals were controlled for apical patency with a K-File no. 10 (Dentsply Maillefer, Ballaigues, Switzerland). Working length was set 1 mm from the apical foramen which was taken using K-File no. 10 (Dentsply Maillefer, Ballaigues, Switzerland). Periapical radiographs were recorded to confirm the working length. The samples were equally divided into three groups (n = 12 teeth per group) for instrumentation with different systems.Roots were embedded into acrylic and then the teeth were scanned by Cone Beam Computed Tomography (CBCT). The sections were 0.9 μm thick from apical to the canal orifice. All cross-section images (uninstrumented and instrumented) were studied at distances 1.0, 2.0, 3.0, 4.0 and 5.0 mm from the most apical point of each specimen.Study images will be reconstructed from the volumetric data set in planes perpendicular to the selected tooth axis. Glide Path was prepared using various file systems in different groups with EDTA gel as lubricant. Apical patency was confirmed by inserting a size 10 K-File. Through the apical foramen during and after the root canal preparation. The canals were constantly irrigated with 2ml of 5% NaOCl solution using a 30 gauge side port opening needle after use of every instrument. After finishing the instrumentation, the prepared canals were rinsed with 10 ml of 17% EDTA solution followed by a final flush with 10 ml of sterile saline to remove the smear layer and any traces of NaOCl.

Group 1: Path Files

Glide path was prepared in the canal by using this file system at the torque and speed provided by the manufacturer and it was rinsed thoroughly with sterile saline.

Group 2: G-Files

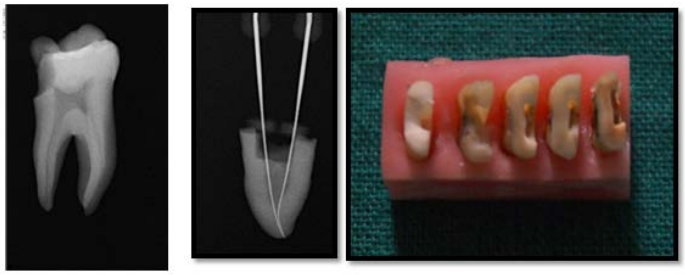
The procedure was followed and done as per manufacturer instructions.

Group 3: Hyflex Glide Path Files

The procedure was followed and done as per manufacturer instructions.

After the roots were embedded into acrylic (Orthoplast, Zeist, Netherlands), the teeth were scanned pre and postoperatively in the high resolution dental mode (i.e. 90 micron resolution). The setting for the CBCT scanner was 84 kVp and 5 mA. All the scans were reoriented with respect to the x-, y- and z-axes, using the imaging software CS9300 equipment (Carestream Healthcare India (P) Ltd). Study images were reconstructed from the volumetric dataset, in planes perpendicular to the selected tooth axes. The transportation, centric ability, surface area

and volume of the root canals were evaluated at 0.0, 1.0, 2.0, 3.0, 5.0 and 7.0 mm intervalsThe pre and post instrumentation images were superimposed using G.I.M.P 2.8.4 software. Comparisons parameters were calculated by subtracting values obtain for treated canals with those from untreated canals through CBCT.



A B C

Figure 1 (A) Pre Operative Radiograph of Samples (B) Working Length Radiograph of Samples (C) Samples mounted on acrylic block.

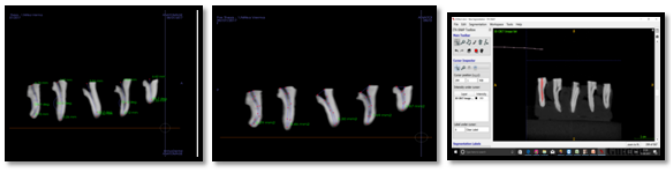


Figure 2 Measuring Canal Curvature, Area and Volume through CBCT software.

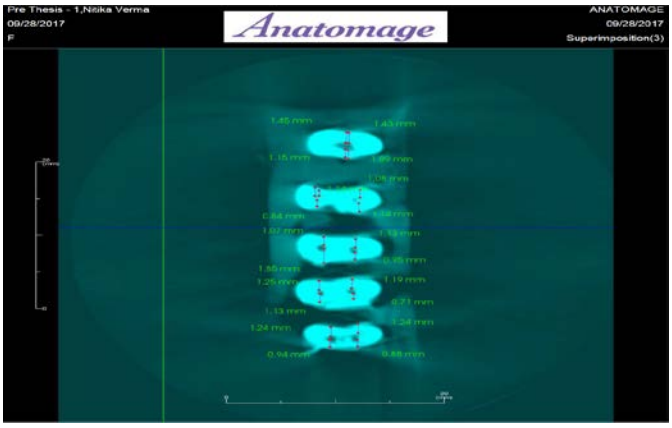


Figure 3: Superimposition Images of Samples using CBCT Software.

Results

The mean difference in Curvature Angle,Area and Volume from pre to post treatment was done between PathFiles, G Files and Hyflex Glide Path Files using the One-ANOVA testt with post-hoc bonferroni test for inter-group comparisons. **(**Table 1,2,3) The mean difference in Curvature Angle, Area and Volume are from pre to post treatment was significantly more among PathFiles in comparison to G Files which was significantly more than Hyflex Glide Path Files. The comparison of mean value from 1mm to 5mm in Mesial aspect was done between pre and post treatment using the Paired t-test. The mean of 1 to 5mm of Mesial increased significantly from pre to post treatment among PathFiles, G Files and Hyflex Glide Path Files. The comparison of mean value at 1mm to 5mm in Distal aspect was done between pre and post treatment using the Paired t-test. The mean 1 to 5mm of Distal increased significantly from pre to post treatment among PathFiles, G Files and Hyflex Glide Path Files.

Table 1: Mean of Curvature Angle between Pre and Post Treatment

	Pre-treatment		Post-treatment				
CURVATURE ANGLE	Mean	SD	Mean	SD	Mean difference	t-test value	p-value
Path File	150.38	7.27	155.10	6.75	-4.72	-3.466	0.005*
G-File	152.47	5.00	157.23	4.97	-4.76	-4.606	0.001*
Hyflex	152.03	5.98	154.44	7.16	-2.42	-2.254	0.046*

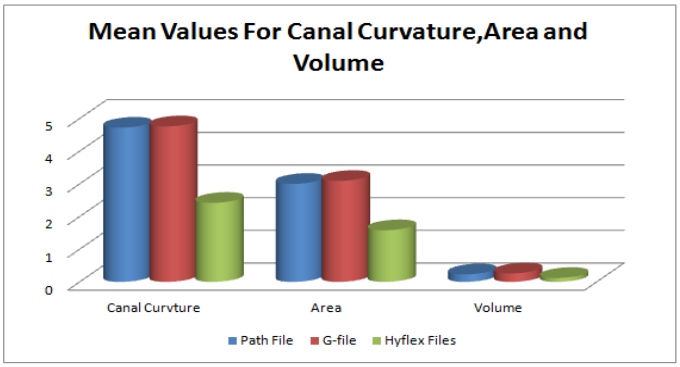
Table 2: Mean of Area between Pre and Post Treatment

	Pre-treatment		Post-treatment				
VOLUME	Mean	SD	Mean	SD	Mean difference	t-test value	p-value
Path File	0.56	0.12	0.80	0.15	-0.23	-8.075	< 0.001*
G-File	0.66	0.06	0.92	0.05	-0.26	-24.989	< 0.001*
Hyflex	0.77	0.12	0.89	0.16	-0.12	-2.358	0.038*

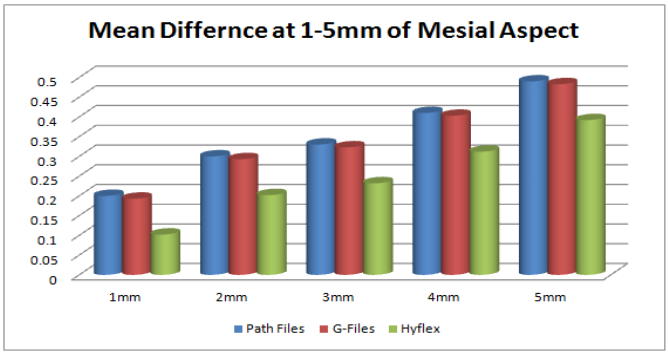
Table 3: Mean of Volume between Pre and Post Treatment.

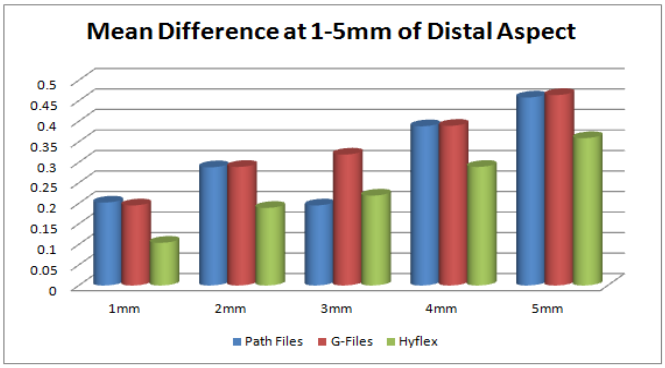
	Pre-treatment		Post-treatment				
AREA	Mean	SD	Mean	SD	Mean difference	t-test value	p-value
Path File	6.07	0.94	9.07	1.04	-3.00	-22.849	< 0.001*
G-File	7.10	1.06	10.19	1.33	-3.09	-10.392	< 0.001*
Hyflex	8.30	0.79	9.88	1.53	-1.58	-4.971	< 0.001*

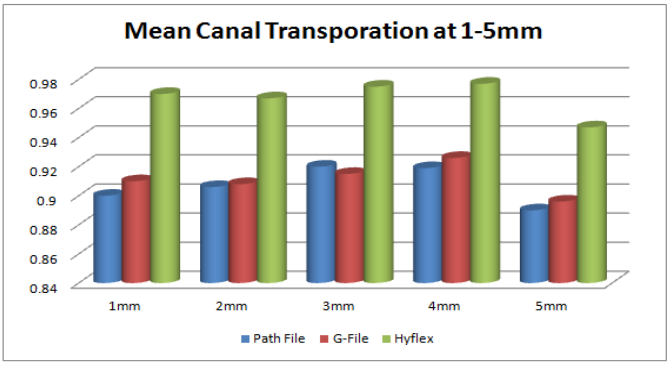
Graph 1: Mean Values of Curvature Angle, Area and Volume.



Graph 2, 3, 4: Mean Canal Transportation from 1-5mm.







Discussion

Coronal enlargement and preliminary creation of a glide path are fundamental for safer use of Ni-Ti rotary instrumentation. Canal scouting and preflaring are the first phases of canal instrumentation during which the clinician might more frequently find procedural difficulties.

Studies suggested that the analysis of modifications in canal curvature after instrumentation is a reliable method to evaluate the tendency of a shaping technique to maintain the original canal anatomy or to straighten the curves. In this study, analysis was performed through observation of changes between preinstrumentation and post instrumentation curvature in the mesial canals in both transverse as well as coronal axis.

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Moreover, preflaring tends to minimize procedural errors such as transportation and ledge formation. Indeed, preflaring permits to maintain a pathway to the full Working Length (WL), avoiding excessive instrument binding in the canal.

In case of severe curvature, flaring the coronal portion of the root canal should be the procedure of choice in order to facilitate the placement of files into the apical segment and prevent excessive flexural stress to the Ni-Ti instruments.

If the canal preparation in the apical-third of the root is not centred, it might lead to blockages, perforations and ledges. This could result in inadequately cleaned canals with the likelihood of persistent apical perioodontitis. Sauaia et al., [30] found that the distal (furcal) root wall of the mesio-buccal canal of a mandibular molar is thinner in teeth with long roots (24 mm) than in short-rooted teeth

(19 mm); it can therefore be justifiably assumed that strip perforations might occur more frequently in mandibular teeth with long roots than short-rooted mandibular teeth. most of the instrumented canals were transported towards the furcal (distal) aspect of the root coronally and the mesial aspect of the root in the mid and apical root sections.

The rationale behind measurement of changes in the cross sectional area was to enable comparisons at standardized cutplanes. Therefore, comparisons with previous work, which measured changes in the total area of the root canal system, are difficult. Our results have shown that regardless of the rotary system used, the cross-sectional area increased at all levels. Nevertheless, there was no difference between any rotary systems at any cutplane.

The mean pre-instrumentation canal volumes were comparable, indicating similar root canal sizes. The mesio-buccal and mesiolingual canals were used given that these canals are prone to iatrogenic errors because they are often narrow and have accentuated curves that increase the level of instrumentation difficulty.Canal volume is a variable used to analyse the effects of canal instrumentation on dentine removal. Overinstrumentation of the root canal could result in excessive thinning of the root. In this study, root canal instrumentation resulted in an increase in canal volume, which improves access of irrigants to the apical-third of the canal, but is also an indication that mechanical debridement might not be as effective apically as it is coronally.

Conclusion

Within the limits of this study the Path Files and G-Files appeared to be suitable instruments used in clockwise rotary motion for safe and easy creation of glide path.

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